Nitrification Inhibitors and Controlled Release Fertilizers

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Why Nitrogen Fertilizer Technology?

• To improve Nitrogen Use Efficiency - NUE

• Given that nitrate is so readily leachable, the use of technologies that can reduce the pool of nitrate, but still make N available in adequate quantities and at the right timing for crop growth could improve NUE
Nitrification Inhibitors

Nitrapyrin (not registered on vegetables)

Urease inhibitor + DCD nitrification inhibitor

DMPP (not available in the US)

Nitrapyrin – low volatility formulation (not registered on vegetables)
Nitrification Inhibitors

\[ \text{NH}_4^+ \rightarrow \text{NO}_3^- \]

- These chemicals disrupt the activity of *Nitrosomonas* and *Nitrobacter* bacteria which are responsible for nitrification of ammonium to nitrate.

- If we can keep more of the applied N as ammonium, there would be less leaching losses.
Impact of Dicyandiamide (DCD) on Nitrate Leaching

Total NO$_3$-N leached (mg/column)

Weeks of incubation

Tim Hartz 2011
Controlled Release Fertilizers

- Coated urea prills (polyurethane and other coatings)
- Chains or rings of urea molecules (can be foliar applied)
Controlled Release Fertilizer

one example

• The diffusion of nitrate out of the prill is controlled by the thickness of the coating and environmental conditions (temperature)

• The coating meters the released nitrate rather than allowing the release of a large quantity that would build up a nitrate pool
Other slow release fertilizers

Calcium cyanamid

Dry organic materials: meat, fish, bone, feather meals

And many others
Factors Affecting NUE

• Irrigation management
  ▪ The key driver in nitrate losses

• Shallow rooted crops
  ▪ Narrow zone where the nitrate must remain in order to be used by the crop

• Short-term, high nitrogen demand
  ▪ Difficult to supply large quantities of N for a short period of time without suffering some inefficiency in nitrate use
Irrigation Impact on Nitrogen Use Efficiency

- One inch of leached water carries 23 lbs of N/A
  - @ 100 ppm nitrate-N in the soil solution
Root Distribution of Lettuce - 60 days old

Two feet

Weaver and Brunner, 1927
Recent Trials Evaluating Nitrogen Fertilizer Technology in Lettuce Production
2011 Lettuce Yield (T/A) Nitrification Inhibitor Trial

Lbs N/A

- 10
- 150
- 100
- 100 + Agrotain
- 100 + 4% DCD
- 100 + 8% DCD

Nitrification Inhibitor Trial

Nitrification Inhibitor

Lbs N/A
2010 Nitrification Inhibitor Impact on Nitrate in Leachate

![Graph showing nitrate concentration over days with different fertilizer applications.](image_url)
DCD applied in drip is diluted in a greater volume of soil and may affect its efficacy.
2012 Lettuce Fertilizer Trial

Timeline

<table>
<thead>
<tr>
<th>Mowed CC</th>
<th>Apply CRF</th>
<th>Plant &amp; anticrustant</th>
<th>Germ Water</th>
<th>Thin</th>
<th>1st fertigation</th>
<th>2nd fertigation</th>
<th>Harvest</th>
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<tr>
<td>April</td>
<td>June 21</td>
<td>June 26</td>
<td>June 29</td>
<td>July 19</td>
<td>July 27</td>
<td>Aug 8</td>
<td>Aug 29</td>
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Irrigation

Over Irrigation

Deep Soil

Apply CRF

Plant & anticrustant

Germ Water

Thin

1st fertigation

2nd fertigation

Harvest

Over Irrigation

Deep Soil

Mowed CC

April

June 21

June 26

June 29

July 19

July 27

Aug 8

Aug 29
# 2012 Lettuce Fertilizer Trial

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total N/A</th>
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<tr>
<td>Untreated</td>
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<td>Standard</td>
<td>155</td>
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<tr>
<td>Moderate</td>
<td>105</td>
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<tr>
<td>Agrotain Plus</td>
<td>105</td>
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<td>G77</td>
<td>105</td>
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<tr>
<td>DMPP</td>
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<td>D45</td>
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<td>D45 + sidedress</td>
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<tr>
<td>D45</td>
<td>155</td>
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<tr>
<td>N-Sure</td>
<td>105</td>
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- Standard received 65 lbs N/A and all moderate treatments received 40 lbs N/A in two fertigations with UN32 on 29 & 41 days after planting.
- D45+sidedress was treated with 50 lbs N/A on 1\textsuperscript{st} fertigation.
- N-Sure was applied as a 50:50 mix with UN32 in both fertigations.
Injection of fertilizer treatments:
• Each treatment had its own main
• Treatments were injected into the ports and each main delivered the N to the associated beds
Excellent Response to Fertilizer

Untreated
Yield Evaluation

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<th>Tons/A</th>
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<th>105 mod</th>
<th>105 + Agrotain</th>
<th>105 + G77</th>
<th>105 + DMPP</th>
<th>D45 105</th>
<th>D45 155 SD</th>
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Nitrogen Uptake by Lettuce at Harvest

![Graph showing nitrogen uptake by lettuce at harvest with various treatments]
Applied N/Uptake N Ratio

Does not account for soil N or leaching losses

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Irrigation Events in Relation to Crop ET from Thinning to Harvest
Nitrate-N in Soil on Four Dates

July 17  July 31  August 7  August 22

- Untreated
- 155
- 105
- 105 + Agrotain
- 105 + G77
- 105 + DMPP
- D45 105
- D45 155 SD
- D45 155
- N-Sure
Nitrate-N at 2 – 3 Feet in Soil

August 15

Average at start of trial (July 2) = 1.6 ppm
Irrigation Events in Relation to Crop ET from Thinning to Harvest

Graph showing irrigation events over time, indicating applied water and crop ET for specific dates from July 27 to August 27.
Nitrate-N at 2 - 3 Feet in Soil
August 31
Summary

• All nitrogen technologies showed great promise for improving nitrogen use efficiency

• Moderate level of N fertilization had improved yield with Agrotian Plus, DMPP, D45 and N-Sure under the conditions in this trial
Summary

• Given the great NUE of the CRF, the rates should be examined to see if we can reduce the loss of nitrate beyond the rootzone observed in this trial
Summary

• The use of these technologies does not preclude the need for good irrigation management